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May 3, 1996

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

Re: RM-8653
Ex Parte Presentation

Dear Mr. Caton:

The attached paper was submitted to Mike Marcus of the Office of Engineering and Technology on March 27, 1996. Copies also have been provided to other Commission staff members in the Office of Plans and Policy and the Wireless Telecommunications Bureau.

At the time this paper was distributed, this proceeding was not subject to the Commission's *ex parte* rules and, therefore, copies of this paper were not submitted for inclusion in the public record. However, Apple has received a number of requests for copies of the paper. In an effort to augment the public record and to promote a full, open debate on the issues raised in this proceeding, Apple wishes to have a copy of this document included in the public record.

In accordance with the Commission's sunshine rules, Apple is not at this time distributing any copies of the attached to any Commission staff, other than this submission to the Secretary's office, and Apple requests that copies of this filing not be distributed to Commission decisionmaking personnel until after the close of the Sunshine Agenda period. Due to public interest in Apple's submission, however, Apple requests that this document promptly be placed in the public record and made available for public inspection.

Two copies are hereby submitted pursuant to 47 C.F.R. § 1.1206(a)(1). If there are any questions in this regard, please contact the undersigned.

Sincerely,

Mary Dent

Enclosure

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March 27, 1996

IMPLEMENTING THE NII BAND: SUGGESTED TECHNICAL RULES

I. Spectrum Assumptions.

The following discussion is premised upon an NII Band allocation of approximately 300 MHz, comprised of the 5150-5300 MHz band and the 5725-5875 MHz band.

Substantial changes in the allocated bands or amount of bandwidth could result in changes in propagation assumptions or hardware technology, or could require sharing among different sets of users. Such changes could require reexamination of matters discussed in this paper.

II. Principal Objectives of the Unlicensed NII Band.

1. General NII Band applications.

The NII Band will be a major advance towards meeting the needs for unlicensed spectrum use — particularly in the classroom and in rural areas; bridging some existing gaps or shortcomings of presently available spectrum, and making possible totally new functions as described below.

Today, most unlicensed spectrum use is confined to the "ISM Bands," in which present and potential interference causes communications to be fragile, and only relatively complex spread spectrum technologies or very low power devices are required by FCC rules to make even modest use of the spectrum resource. For selected applications, the Data-PCS band (2390-2400 MHz) is a large step beyond the ISM Bands, in that it provides a markedly cleaner interference environment, and is a band that is nearly ideal for low-cost hardware for simplified network environments, such as those encountered in schools. In the long run, some further roles in the array of necessary spectrum bands will be filled by the unlicensed mm wave bands, which have distinctive, somewhat limiting propagation characteristics. Taken together, these presently available bands fulfill only part of the needs for unlicensed wireless communications

Two applications of the NII Band, local area network Very High Rate ("VHR") systems and longer distance community networks, will be emphasized below because they represent special needs that can be satisfied in the near term only in the NII Band. Emphasis in this paper on VHR networks and longer-distance links does not imply that the NII Band technical rules should limit the band to these applications. To the contrary, the technical rules must be flexible enough to permit a wide

range of uses and users, limited to the maximum extent possible by physics rather than by regulation. For example, while NII Band power limits and other technical restrictions would make it impossible to deploy fully mobile cellular- or PCS-type service over a wide area, the regulations should not themselves prohibit any technically suitable applications.

2. **Higher-bandwidth local area communications (predominantly in-building).**

Individual computer users in businesses and, soon, in educational institutions, are communicating more and more information and connecting with vastly expanding on-line information resources, including those of the Internet and, ultimately, the NII. At the same time, the number of such users is increasing and those who are within radio range must share the spectrum resource. The aggregate of these demands requires new networking and communications technologies, known generally as Very High Rate ("VHR") local area computer networks, and, therefore, substantially greater radio spectrum than is now available.

Unlicensed wireless VHR devices operating in VHR networks will provide for multimedia and other information-intensive communications within buildings and nearby areas. The NII Band will, for the foreseeable future, be the only possible spectrum for VHR operation.

3. **Longer-reach community networks (predominantly out-of-doors).**

While there is presently some, albeit limited, spectrum available for wireless LANs, there is an immediate, unmet need for practical, low cost, longer-reach unlicensed wireless connections, to provide moderate data rate links between separated sites and for point-to-point extensions beyond the bounds of a VHR system. Predominately outdoor NII Band links could reach across a street, throughout several blocks, around a town center, among the schools of a district or, in rural areas, across tens of kilometers. The specific distances that could be achieved on a particular link would depend on many factors including signal bandwidth, antennas, technology and terrain.

Unlicensed links could form all or a portion of a "community network," depending on the local availability of alternatives. Individual users would select from among different options based upon considerations such as price, reliability, bandwidth, and ease of implementation, to create each pathway in an overall network. Some users may be able to use reliable (and more costly) alternatives — such as traditional fixed microwave or wired connections — for portions of their

network, but it important that a relatively low-cost, flexible, and easily implemented NII Band alternative be available.

Many wireless community network links will be established by public interest, non-profit, local government, or affinity groups, and by individuals who wish to participate in the information exchange of such groups. These links could be used to communicate within the group, or to establish a connection between the group and other resources, such as commercial Internet Service Providers. Given a supportive regulatory and technical environment, such organizations (*e.g.*, a school or library system, a local chamber of commerce, or a group of government users) could coordinate frequency usage with one another and to take steps to maintain order in the airwaves, as will be discussed below.

III. Basic Requirements for NII Band Technical Rules.

1. Adequate and appropriate bandwidth.

The NII Band allocation must be substantial and scaled to the *aggregate* need for spectrum in the anticipated area of operation — *e.g.*, for VHR networks, a particular floor-space in a building and, for outdoor links, over a wider geographical area. If the amount of spectrum allocated for the NII Band is too small, it will not meet existing or future bandwidth demands; disputes will break out over segmenting and protecting bands for proprietary access etiquettes and applications; there will be no room in which dynamic frequency selection and other sharing methods can be employed; broad, frequency-wasting "guardbands" will be implanted between "channels," and at any given location some designated "channels" will be unused while others will be overloaded.

The two 150 MHz portions of the NII Band were selected because they provide an adequate spectrum resource without excessive preexisting subdivision, because their allocation to the NII Band will not adversely effect pre-existing and continuing usage by other services, and because propagation characteristics of the 5 GHz region are favorable for both indoor short-range and outdoor usage of the NII Band.

2. Flexibility.

The NII Band requires a basic order-keeping framework of rules, but unnecessarily rigid or burdensome rules would be counterproductive. As noted above, the NII Band must be able to support a diverse array of present-day and future wireless technologies and user applications, including different bandwidths; different densities of users; different

distances; different mixes of voice, video and data; different degrees of traffic urgency and security; and different requirements for reliability.

With one exception, a single set of overarching, but highly simplified, rules should govern operation within the entire NII Band. That sole exception would be a special set of rules governing operation within two high-speed "VHR" channels, discussed in detail below. Elsewhere, there should be no rigid channelization barriers or unrealistic demands (in terms of technical complexity, cost, prior coordination, etc.) placed upon either hardware *or* users.

3. "Part 16" operation.

The NII Band should be governed and protected within a "Part 16" model. That is, no *new* classes of licensed or "protected" users should be introduced into these frequencies once they are allocated as the NII Band. Government radar, the amateur service, satellite uplinks/gateways, and spread-spectrum devices operating under Sections 15.247 and 15.249, would continue to use the band.

4. Process.

The Commission promptly should allocate spectrum for the NII Band and adopt a minimum set of rules governing operation in the band, as described herein. Industry and users then will be free to develop additional formal and informal practices for band sharing and for mitigating interference. With respect to community networks, local needs and practices, as discussed below, should guide NII Band usage.

IV. Principal Recommendations.

1. Very High Rate ("VHR") systems.

a. Definition of VHR devices.

The development of and definition of technologies and standards for VHR systems are in a very early, formative stage. The VHR system that is most advanced, in this regard, is HIPERLAN — a VHR function that has been allocated spectrum in Europe and which is optimized for packet data. Even before the HIPERLAN standard has been adopted, however, some HIPERLAN developers have begun moving towards other as-yet-undefined VHR technologies, some of them aimed at maximizing voice-like traffic.

One potential VHR application, so-called "Wireless ATM," presents a vision of a technology able to convey mixed traffic, including data and

real-time voice/video, in a manner effective for both. Many in the computer and telecommunications industries also hope that Wireless ATM will offer nothing less than a seamless medium on communication routes that are comprised of both wire and wireless elements. Unlike wired ATM, however, Wireless ATM is being addressed only now and has not yet been defined uniformly, much less implemented. Many Wireless ATM development efforts remain entirely proprietary and, therefore, do not yet have widespread support. This condition is likely to change radically as companies and groups, such as the ATM Forum, address the topic. It is important, therefore, even at this stage of their development to allow for classes of Wireless ATM systems to be among those VHR technologies that can be used in the NII Band.

VHR concepts that are being advanced in the industry seem to share the following general attributes:

- VHR devices themselves would be required to have the capability of conveying digital information at data rates exceeding 20 Mbps. (Note that data rate, not RF bandwidth, is the qualifying attribute. Direct sequence spread-spectrum systems would qualify only if their data rate, not their chip rate, meets the minimum for VHR.) Minimum data rates such as 20 Mbps (or more) can entail equipment capabilities that can raise costs beyond those of lower-rate systems, so VHR technologies are not necessarily optimum for some applications.
- Devices would operate on a band that would be divided into channels, with the width of a single channel being in the nominal range of 20 to 50 MHz (depending on the VHR scheme) and channel spacing to suit.
- Until technologies for mixing traffic, such as Wireless ATM, are developed, VHR systems with disparate requirements for channel access or retention, such as for packet-switched data vs. circuit-switched, guaranteed-service voice/video would be in conflict and, therefore, would preclude overlapping coverage areas on either the same or adjacent channels.
- Even without considering conflicting operational modes, multiple systems — whether like or unlike — are not expected to be able to operate on adjacent channels simultaneously within an overlapping coverage area, because of RF interference among adjacent systems.

- VHR systems and devices will be optimized for in-building operation, with maximum in-building distances of a few meters or tens of meters, through several walls.
- The wide bandwidths and low power limits of VHR systems result in low spectral power density, a small coverage area and, incidentally, vulnerability to interference from nearby VHR and narrower-bandwidth devices, if the latter are permitted to operate in the same frequencies.

The NII Band technical rules would provide a suitable spectrum home for VHR systems that have the general attributes, particularly minimum data rates greater than 20 Mbps, described above. Due to the state of development of VHR technologies, however, no portion of the NII Band should be dedicated to any single VHR technology or otherwise regulated in a manner that could have the effect of excluding other VHR technologies that have the characteristics set out above.

b. **Dedicated VHR channels.**

As noted above, some potential manufacturers and users of VHR systems are concerned about interference from narrow band transmitters (sometimes inaccurately portrayed by opponents as "high power" community network links, not to mention an enormous array of applications that do not require a constant rate of 20 Mbps or more), if they were allowed to operate on the same frequencies. However valid or invalid these concerns may be, complete segregation of VHR systems in the NII Band should put these concerns to rest. Accordingly, to assure appropriate frequencies in the NII Band for both VHR and community network systems, the NII Band allocation should dedicate two widely separated channels exclusively for VHR system operations.

The lower VHR channel should begin at 5150 MHz, as consistent with the lower limit of the HIPERLAN band in Europe, and the upper VHR channel should begin at 5725 MHz.

These two separated channels will permit cellular-like re-use, or allow co-location of two systems using mutually hostile technologies, each operating on one of the two different protected channels. Alternately, the two channels could be used at a single site to make more aggregate bandwidth available at that location.

Frequency separation of the two VHR channels is essential for effective use of the spectrum. If VHR channels are contiguous, spillover of a transmitter's emissions envelope, coupled with less-than-ideal receiver skirt selectivity, would make it necessary to reserve a buffer or idle

(guardband) channel between two occupied channels at a single location. Moreover, in the case of three contiguous channels, a single user of the middle channel could foreclose usage of the channels on both sides. By separating the channels, those two separated channels would afford approximately the same VHR capacity as three contiguous ones, and it is not necessary to "waste" a guardband.

c. **Required VHR channel capacity.**

The physical coverage radius of VHR devices can be measured in a few meters or tens of meters inside buildings. It is difficult to project what an individual's bandwidth requirements may be in the future, how trunking efficiencies may come into play, how much channel access and retention overhead will reduce or increase users' needs, the nature of traffic, and other elements. However, given that the two VHR channels can be used to their fullest extent, one of the major benefits of VHR operation is the very large capacity that will be available.

Several countries in the European community allocated 100 MHz for HIPERLAN, deeming it appropriate and necessary for VHR communications in buildings while taking into consideration frequency reuse as well as restrictions on using adjacent channels simultaneously. In accordance with the draft HIPERLAN standard, this 100 MHz is divided into three contiguous HIPERLAN "channels," each delivering 23.5294 Mbps. VHR schemes other than HIPERLAN could provide more throughput, providing a single channel capacity that is several times that of, for example, a traditional Ethernet network. Such networks have been sufficient in the past for many applications even when shared among many users.

No one expects such capacity limits to be sufficient in the future. The precise set of technologies that will be available also is indeterminable. Two protected VHR channels of 50 MHz each would provide an appropriate resource for now and allow VHR technologies to be developed and used.

d. **Operation within the VHR channels.**

As noted above, different VHR systems may not be able to share the same channel within a coverage area because the nature of their traffic (*e.g.*, real-time voice/video vs. packet data), would make conflicting demands for channel access and retention.

Rather than deal with this potential for conflict by designating a single permissible VHR technology from the outset or mandating an

overly complex type of channel management (or access etiquette)"overhead" to mediate among conflicting technologies, Apple recommends that the Commission adopt the Part 15 model for VHR operations. Using this model, in some circumstances, there may be conflicting uses and thus reduction in Quality of Service ("QoS"), but that for many users this risk is more than offset by the benefits of unlicensed operation. In addition, there should be increased emphasis on having users employ administrative measures, as contrasted with technical measures, to enhance sharing.

It would be quite premature, and indeed virtually impossible, to model rules around a single VHR standard at this stage of VHR development. Other than the HIPERLAN standard that is pending acceptance, there is no standard upon which to build rules. Attempting to do so would stifle future development and would limit function to a single vision that has not, at this time, even been articulated by any party at any level of detail. Waiting for a sufficiently wide range of vendors and users to develop and agree upon a single VHR technology, much less to promulgate a suitable standard in the Code of Federal Regulations, would cause unacceptable delays in implementing the NII Band.

Mandating a particular channel-access etiquette would be similarly unwise, not only because it impossible for the reasons already noted, but also because it is not necessary. Each VHR system will be confined to a small coverage area determined by power, bandwidth, modulation scheme, receiver capabilities and other characteristics, as well as in-building obstacles, multipath symptoms and other propagation features. In most cases, conflicting uses will be avoided without an access standard, due to the fact that mutually incompatible systems are unlikely to be used within these small physical areas.

Imposing an access etiquette on all devices would force every system to pay a high price in terms of cost, complexity and channel-management overhead to deal with relatively rare cases, such as the proverbial shared, unshielded wall between antagonistic business offices where frequency-administration does not succeed. In addition, an access etiquette would complicate the design and equipment authorization process for VHR devices, since certification would have to be based upon a highly complex device-interaction suite of access-etiquette-compliance tests rather than the testable properties of a single device.

Industry always will be free, of course, to develop *de facto* standards or sets of products with differing service provisions. These market-driven functions could feature inter-operability among systems from different manufacturers, or they could differentiate products by cost vs.

performance features. Either of these approaches would be comparable to the processes that have driven development and use of wired networks.

At this time, several manufacturers have made the case that each VHR RF channel should be 50 MHz wide, even for 25 Mbps systems, to reduce technical requirements and costs of transmitters and receivers. Whatever choices are made for the VHR channel widths, subdivision of those channels (channel splitting) should be explicitly prohibited. A substantial value of the VHR channels is their integrity as being appropriate for a class of wideband systems, a virtue that would lost if multiple, narrower-bandwidth devices are permitted. Such devices must be required to operate elsewhere in the NII Band or in other services.

For the reasons stated above, both VHR band segments should be open to all VHR-compliant devices: *i.e.*, neither band should be dedicated to any particular technology and users should be allowed to choose any VHR technology for any particular site and channel.

e. Operation of VHR devices outside the VHR channels.

While an adequate, protected channel capacity that is explicitly hospitable to and reserved for VHR operations is essential, VHR systems should not be precluded by the rules from operating elsewhere in the NII Band, but when they do, they would have to operate in accordance with the rules for non-VHR systems. The frequency-reuse benefits from the short-range nature of low power, high-bandwidth VHR systems, also make these systems relatively benign as sharing partners (notwithstanding that they can cause interference somewhat beyond their meters or few tens of meters of communications range).

Accordingly, local conditions permitting, VHR devices should be permitted to operate anywhere in the NII Band. When operating outside the VHR bands, VHR devices would be treated (regulated) in the same manner as any other NII Band occupant, including observing any "etiquette" that pertained to spectrum use in that region of the band.

f. Internationalization of VHR systems.

The HIPERLAN standard has been under development in Europe for 5 years. At this time the standard has not been approved and implemented, but as observed above, some European countries have allocated 5150-5250 MHz for such systems while other countries have allocated 5150-5300 MHz. The lower NII Band in the U.S. is intended to be identical to the larger HIPERLAN provision. The upper NII Band has no

European counterpart at this time, thus not all devices qualifying for the VHR "reserves" in the NII Band in the U.S. would qualify for the HIPERLAN allocation in Europe.

There are additional requirements for European HIPERLAN, some being designation of RF channels 23.5294 MHz wide and a requirement for devices to communicate at 23.5294 Mbps, employing a specific modulation scheme. Assuming that the HIPERLAN standard is approved in Europe (which is not certain), U.S. manufacturers should be allowed to build identical HIPERLAN-compliant devices for both markets.

For this to be possible, the threshold (lower limit) of data rate in the U.S. for VHR qualification must not be so high as to outlaw HIPERLAN, and all other NII Band regulations should accommodate (but not require) HIPERLAN-compliant devices and functions. That is to say, any efforts by manufacturers to force a minimum data rate of 25 Mbps, to discriminate against HIPERLAN even before Wireless ATM or other technologies have advanced further, should be rebuffed. If HIPERLAN is modified in the future, or universally replaced with another VHR approach, the FCC and industry should take reasonable steps to accommodate any such new or modified system.

2. **Community Networks.**

a. **Definition of community networks.**

Perhaps the most important benefit of the NII Band will be its singular ability to provide for longer-reach, unlicensed communications links. These longer-reach links, that would constitute a portion of what are referred to as community networks, will fill a gap between heavily engineered and costly licensed service-provider systems or extremely expensive private-user installations, and unlicensed wireless technologies available to the public for immediate use and at reasonable costs.

As an initial matter, it is important to clarify what is meant by the term "community network." "Community networking" does not refer to any particular set of distances, applications, user groups, or network structures. In particular, it does not refer solely to a large, formal, or structured network. Instead, the term encompasses a variety of network structures and applications; broadly stated, it is any network created by a set of users to provide communications within the group and/or between the group and other communications or information resources.

Wireless community network links can be combined with wired structures or licensed-wireless services, or they can operate as stand-alone

resources, depending on the needs of an individual user or group. They can be as simple as a single point-to-point radio link making it possible for a bedridden schoolchild in a suburb to "telecommute" to school, or as relatively complex as a carefully engineered and optimized library network through which patrons can browse a system-wide electronic card catalog, download electronically-stored resources, and arrange inter-library loans. Individual unlicensed links can be combined into larger networks that enable a neighborhood action group or civic association to connect its participants. In a rural area where telephone service lines are noisy, it could be the only practical way for residents to reach an Internet Service Provider, particularly at the higher data rates favored for accessing the levels of content so abundant in the World Wide Web.

With the exception of VHR, there is no sharp dividing line between community networks and other NII Band applications. NII Band devices will support numerous permutations of distance (from local to multiple-km point-to-point connections); offer varying bandwidth or data rates (from perhaps 50 kbps to tens of Mbps), levels of reliability (from *life-critical* information links that most properly should use licensed radio services, if available and affordable, to *life-enhancing*, best-effort information conduits), and complexity (from blister-packed complete systems to individually engineered networks); and will be available at a variety of costs (for basic and extra-feature hardware capabilities). The creation of longer distance network links will be achieved through tradeoffs among power, bandwidth, and antenna directionality; these links, however, will not be fundamentally different from other, shorter distance point-to-point links.

The ability of the NII Band to support longer-distance links is of fundamental importance. At this time, the only provisions for unlicensed data communications beyond an immediate premises entail the restrictions imposed by spread spectrum and the resulting limited data rates imposed by hopping channel bandwidths or spreading gain requirements, as well as tight constraints on antenna gain. Community networks need not be "singled out" or unique regulatory requirements imposed on them. Particularly, once there are separate VHR portions of the band from which community networks are prohibited, no special technical rules are required to support longer-distance links or to protect other NII Band users from their operation.[1]

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[1] (The Commission's current NPRM proceeding (96-8) on modifying the "spread spectrum rules" addresses one narrow set of technologies, usage scenarios and implementations. In its present form, some portion of the needs for fixed-position, lower bandwidth connections would be met, but a much larger set of needs will remain unfulfilled. In particular, the whole concept of Community Network goes far beyond just those nodes that can be

Unlicensed community networks, however, will not support effective wide area mobile communications that would substitute for cellular, CDPD, PCS, mobile data, SMR networks or paging networks. NII Band power levels will not be sufficient to create longer distance, wide-area coverage; rather, distance will be achieved principally through the use of directional antennas and, as a result, distance and wide-area coverage largely will be mutually exclusive. Moreover, the limitations of shared unlicensed spectrum are inherently ill-suited to the very large investments required to construct and operate a PCS, cellular, or other similar network.

b. Sharing frequencies between community networks and other NII Band devices.

Several parties have expressed concern that some indoor systems could not coexist on the same frequencies with community networks because of the purported "high power" (EIRP) of the latter. Whether this is a realistic possibility or a market perception issue, as discussed above it can be answered by providing VHR systems their own sub-sets of the NII Band, in which directional community network links will not be permitted to operate. As a result, VHR devices can be assured a "safe" environment merely by limiting their operation to these protected channels.

Outside the VHR channels, indoor systems will be protected to a significant extent by the attenuation of 5 GHz signals passing through the exterior walls and windows of a building. This attenuation alone is of similar scale to the directional gain of an 18" parabolic dish, and has been well noted in numerous studies and examples of penetration of PCS into buildings. Moreover, achieving satisfactory coverage within a building is not always a easy task even with all stations inside the building. Serious interference, from sources outside the building, is even less likely.

Thus, extended-reach community networks generally present no more interference threat to indoor operations than would nearby indoor wireless LANs. As a result, it is not necessary either to require prior coordination of point-to-point community network links with wireless LANs, any more than it is necessary to coordinate among those LANs.

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installed professionally and permanently. Furthermore, spread spectrum modulation schemes, particularly direct sequence schemes, are best employed where there is little likelihood of narrow-band interference that would disable them.)

c. **Sharing frequencies among community networks.**

The concept of medium-reach point-to-point links, sharing a set of frequencies without extensive formal frequency coordination requirements or mandatory, "mutual-awareness" channel-access etiquettes, can arouse visions of chaos or, as it is sometimes called, a "tragedy of the commons." In the "tragic" scenario, users' lack of a shared self-interest to employ spectrum-efficient radios leads to excessive interference among systems and results in a wasted spectrum resource.

It is critical that predictions and fears of a "tragedy of the commons" not be overstated. Indeed, the entire premise of the "tragedy of the commons" argument is that community networks will be so heavily used — *i.e.*, are so well suited to meeting the communications needs of individuals across the country — that interference problems will arise. It would be unfortunate to prohibit a much-needed technology because a limited number of cases could arise, at some point in the future, in which excess demand could adversely affect users by, for example, reducing throughput rates.

The types of users who will be drawn to community networks will require lower costs, greater flexibility, and often will have fewer resources to participate in the regulatory process. Unlike subscribers to carrier-provided networks, moreover, users of community networks are more likely to be directly involved in making network operation, and their investment, worthwhile. These users should be permitted to forego the ultimate reliability of carrier-provided networks or frequency-coordinated, fixed-microwave stations in exchange for lower cost, more flexible alternatives. Rather than dictating a complex, high-cost, high-reliability system, the Commission should permit consumers to decide which alternative best suits their needs and resources.

In any event, as with most "parades of horribles," it is unlikely that the worst case scenario in the tragedy of the commons will come to pass. First, NII Band devices and systems would operate as computer data, not telephony, networks. In data networks, the "call blockage" one associates with telephone networks does not occur. When data network capacity capabilities are overburdened, traffic presented to the network can be backed off and delivery will slow down. In this instance, some users might choose alternate media or delay transmission.

Second, reasonable administrative means are available to NII Band users to minimize or avoid a breakdown of the network. While all users may not perceive the need to use spectrum-efficient radios, their self-interest in having a usable channel will prevail and they will cooperate in

channel use, if the barrier of user and transmitter anonymity can be overcome so that cooperation can be effected. For this reason, every possible, non-intrusive "hook" to facilitate informal coordination should be provided.

i. Transmitter IDs.

The Commission should require imbedded unique transmitter ID, sent at appropriate intervals in a series of transmissions, much like a requirement for transmitting authorized call letters.[2] This transmitter ID code would be set permanently by the manufacturer and could be used at the point-of-sale to "register" a "responsible entity" or contact person initially associated with obtaining a device and putting it into operation.

Once a device has been "registered," basic information as to intended frequency use could be entered into a publicly available, on-line data base which, in turn, could be reviewed by potential users and into which actual users could place information about their equipment, such as performance and general location features, including directional path orientation (if any).

ii. Informal coordination.

Once a basic registration system is provided for, a system for coordination could be as useful as operators would like it to be or are willing for it to be. Such a system might be particularly effective for relatively immobile systems, point-to-point or otherwise. For example, a private coordination entity could designate a gross level of coordination for mobile and fixed stations, recommending channel sets for particular classes of users, or designating certain frequencies for certain applications in specific geographical areas (as is the practice for licensed private land mobile stations, which do not have exclusive, dedicated spectrum).[3]

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[2] A limited set of means of transmitting IDs would have to be allowed, to cover diverse modulation schemes, operating characteristics and other technical factors.)

[3] In order to decide whether, and if so how, to implement a frequency registration and coordination system, the Commission should solicit the views of those who would be affected by the system, in particular from potential users of unlicensed community network links. The Commission should seek comment on the following issues: (i) whether the benefits of such a system would outweigh its burdens; (ii) whether an imbedded unique transmitter identifier should be required, (iii) whether an open, publicly accessible database is the best solution; (iv) whether such a database should be maintained on a national, regional, or local level; (v) what entity or entities should be responsible for establishing and maintaining the database; (vi) whether participation would be mandatory (*e.g.*, required under the FCC's rules as a condition for operating certain types of equipment, such as highly directional antennas, in the NII Band); and (vii), if mandatory, how participation would be enforced.

iii. Possible "licensing."

While Apple does not think it necessary, if the Commission wishes to test the risks of the "tragedy of the commons" among community networks, an additional approach would be to permit antennas with a gain greater than is currently permitted under Section 15.247 to be "licensed" only to certain "designated eligibles," such as libraries, educational entities, local or regional government agencies, health care providers, and other charitable and non-profit groups, or non-profit agents selected by the eligibles, who would be responsible for proper operation and for "best-effort" coordination and registration.[4]

In this scenario, only certain designated classes of entities, specified in the Commission's rules, would be authorized to use certain types of NII Band equipment pursuant to a type of license that would be issued through a "postcard" application process. For-profit entities that do not otherwise qualify would not be permitted to buy, install and operate community network links employing highly directional antennas. In this way, the people who need community networks the most would not be deprived of the opportunity to use them because of fears that commercial entities would occupy the NII Band and create the chaotic conditions that would prevent anybody from communicating on these frequencies.

3. General NII Band rules.

Every manufacturer and every user wants, and must have, a usable spectrum environment. The real question is, what are the minimum regulations that will make and keep that environment in the NII Band ?

With the exception of the VHR sub-bands, the Commission's rules should be uniform across the NII Band. They should require operations that emulate the way computer networks work. Computer networks share the medium on a best- effort, bit- or byte- or packet-by-packet basis. Such rules might simply impose a limit in the time that a transmitter can hold a channel, before allowing others to contend for it.

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[4] Whether or not the Commission resorts to creating a category of eligible licensees for community network facilities, the Commission should forbid the use of the NII Band for point-to-multipoint video entertainment services, which could occupy vast quantities of bandwidth and deprive non-profit, community groups of the Band's intended benefits.

The rules should assure that signals go no farther than necessary, and not unnecessarily in the wrong direction. In many circumstances, that indicates low-power transmitters and antennas that concentrate the signal pattern.

a. Frequencies and channelization.

NII Band devices should be permitted to be fixed-frequency ("non-tunable"), "pre-settable" at time of installation or setup, or "dynamic" and able to interact with other traffic and search for available channels. The first of these might be less costly but completely sufficient for some locales; the last more costly but better able to deal with a congested spectrum environment.

The band should not be subdivided by regulation into fixed channels, whether in order to favor a particular functionality or proprietary technology or to maximize a particular mode of operation at the expense of other modes. Wideband devices should be encouraged to operate or be tuned near one end of the band, when possible, and narrow band devices near the other end. The definitions of "wide" and "narrow" should be permissive.

Guidelines should identify preferred incremental sets of center frequencies, rather than allowing devices to "slide" anywhere in the band. For example, center frequencies, spaced 100 kHz apart, might be suggested for the part of the band where narrow band systems should be directed. Near the other end, the center-frequency increment might be 1 MHz. Such a constant-increment comb of frequencies would provide at least a first-level technical identity of the environment that a station might be operated in and, by reducing possible choices, could be used to support development of informal, permissive access etiquettes. The preferred center frequencies would not be coupled with any bandwidth limits. (Special cases of irregular adherence to a constant-increment channel scheme could include additional provision for the center frequencies of HIPERLAN-compliant devices on increments of 23.5294 MHz.)

Finally, the guidelines might identify "special" or "default" channels for special purposes, such as emergency and travel-assistance communications.

b. Bandwidths.

There is no reason to establish, *a priori*, rigid requirements for signal bandwidths. The United States presents multiple sets and great extremes of community and radio environments. Much, if not most, of the land is

not congested with either people or radios, at the scales of service (from 10s of feet to 10s of km) addressed by the NII Band.

Currently, it seems reasonable to expect many wireless systems to be designed and installed to convey data rates quantitatively related to wired networks now in popular use or emerging— ISDN, T-1, Ethernet, and ATM, respectively — and the NII Band should allow these particular applications. It would be a mistake, however, to preclude faster or slower rates; to ignore technical trends for data compression or of requirements for more definition; or to conclude that those four data-rate centers of gravity will still prevail five or even two years from now. The demand for faster Internet access, alone, can produce more changes in user requirements in a few months than have been accomplished by multi-year standards activities. The NII Band must be and remain flexible.

If the FCC's rules require a minimum bandwidth for NII Band signals (other than those in the VHR channels), it should not be set too high. There are many worthy low-bandwidth applications that should not be excluded from the band. Nor should they be allowed (or required) to spread their RF bandwidth solely in order to be eligible to transmit. A minimum occupied-bandwidth of 50 kHz would be appropriate for voice-like services and many low-rate data delivery mechanisms. Devices should be allowed to change channels dynamically and to scale bandwidth to demand.

No upper bound of bandwidth *per se* should be imposed, as long as any bandwidth that is occupied is being used to advantage one's own communications and not, for example, to disadvantage the ability of other devices to access the spectrum or communicate.

c. **Access etiquettes.**

The question of a workable access etiquette is a complex one. Many factors will dictate the shape of band usage: adjacent in- and out-of-band occupants, incumbents, hardware, costs, network interactions (such as any interface between wired and Wireless ATM or any number of other schemes).

The etiquette codified in Subpart D of Part 15 depends upon a "listen-before-talk ("LBT") algorithm based upon energy sensing (not information exchange between devices). It also requires complex monitoring, "packing," searching, threshold detection, tradeoffs between transmitter power and received signal characteristics, an array of minimum microseconds and maximum milliseconds (and for some applications up to multiple hours) of required responses and activities,

and much more. Given the wide range of connection and sharing scenarios in the NII Band, LBT may prove impractical, or in some cases it may impose more burden on radio design and operation than it justifies by interference reduction. LBT should, of course, be allowed.

Even though it would be premature to impose rigid rules, the Commission should work with interested parties to develop additional guidelines that could further maintain order in the NII Band. These guidelines would provide a starting point for affected parties to develop industry standards and to determine the appropriate "weight" to be given to them (*e.g.*, binding industry standards, voluntary open protocols that permit inter-operation, etc.).

Manufacturers, technical groups, and users have a solid record of successfully developing their own "rules," not regulatory strictures, particularly by adopting *de facto* standards that are developed and implemented well before formal standards can be universally agreed upon. The best example of all is, of course, the Internet.

d. Other.

The restraints on antenna gain and power output for LAN or short-reach radios should be no more rigorous than those applied to present-day radios that are permitted to operate at power levels up to 1 watt pursuant to Section 15.247. In no case should the permitted power be greater than 1 watt, as is currently allowed (and proposed to be maintained) in the 5725-5850 MHz segment (see NPRM, ET Docket No. 96-8, released February 5, 1996).

Lower power radios of ≤ 100 mW should be subject to even fewer restraints. In particular, there should be no limits on the directionality of antennas used with such devices, and therefore no "unique coupling" should be required to connect an antenna to a transmitter having a output power of ≤ 100 mW. If, however, the Commission should find it necessary to limit antenna gain in general, it should permit "licensing" of longer-reach systems to certain "designated eligibles," without limits on antenna gain, as discussed above (see section 2c. iii.).

"Radiated power" further should be limited expressly in accordance with Section 15.319(i), which requires manufacturers to affirm compliance with IEEE C95.1-1991. It also provides an exemption from SAR testing of devices having a power of ≤ 100 mW.

Spread-spectrum technologies should be permitted and even encouraged, but not required. In areas where there is little probability of

interference from narrow-band radio systems, the processing gain of direct sequence spread spectrum devices, operating pursuant to either Section 15.247 or the NII Band rules, can increase the expected reach of a transmission of a given signal power without necessarily increasing the difficulty of sharing with narrow-band systems.

Analog modulation should be forbidden in the NII Band, subject to defining Wireless ATM or other VHR systems and how, if at all, a dedicated VHR segment should be regulated beyond a minimal requirement that the channels be used only for VHR systems. Any fair-access etiquettes should be based on essentially packet-switched operation throughout the NII Band.

REACHES OF REPRESENTATIVE COMMUNITY NETWORK CONFIGURATIONS

Real performance will be site-specific; propagation models used are only approximations and consider only outdoor clear paths.

Configuration>>>	**Dish-to-dish**	**Br'dcst to dish**	**Br'dcst to portable**	**Portable to portable**
Service reference and approximate required bandwidth				
ISDN: nominal 0.2 MHz				
10 dB Fade 6 dB rx	30,000 m	4,500 m	700 m	500 m
0 dB Fade 6 dB rx	70,000 m	13,000 m	1,600 m	1,200 m
T1 2 MHz: nominal 2.0 MHz				
10 dB Fade 6 dB rx	14,000 m	2,500 m	300 m	230 m
0 dB Fade 6 dB rx	30,000 m	5,500 m	700 m	500 m
Ethernet: nominal 12 MHz				
10 dB Fade 6 dB rx	7,000 m	1200 m	150 m	120 m
0 dB Fade 6 dB rx	16,000 m	3,000 m	350 m	250 m
W/l ATM: Nominal 35 MHz				
10 dB Fade 6 dB rx	4,000 m	800 m	150 m	100 m
0 dB Fade 6 dB B rx	9,000 m	2,000 m	400 m	300 m

Some of the assumptions:
Net gain of 18" dish at 5 GHz is approximately 24 dBi.
"Broadcast" antenna is favorably positioned and offers approx. 4 dBi gain.
"Portable" antenna is omnidirectional and has 0 effective gain.
Tx Power 100 mW.
Rx noise figure approximately 6 dB.
Fade margins as indicated: 10 dB or 0 dB.
No processing gain considered.
Path attenuation coefficient approximately 2.7.